

**PROTOGYNOUS HERMAPHRODITISM  
IN *Xyrichthys novacula* (L. 1758)**

by

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**RÉSUMÉ.**— Un ensemble de 48 *Xyrichthys novacula*, du Golfe de Naples, a été l'objet d'une étude morpho-histologique. L'analyse des gonades a mis en évidence les premières phases d'inversion sexuelle et la présence constante d'oocytes primaires dans tous les testicules. Les corrélations entre la livrée, les dimensions et l'état des gonades ont permis de déterminer la plus petite taille à la maturité des mâles. L'hermaphrodisme protogynique monandrique a été confirmé chez cette espèce.

**SUMMARY.**— An anatomical study of 48 *Xyrichthys novacula*, caught in the Bay of Naples, revealed the early stages of sexual inversion in the gonads. From the correlations between colour pattern, size and functional state of the gonads we determined the shortest length at maturity for the males, and confirmed that this species is monandric protogynous hermaphrodite.

**Key-words :** Pisces, Labridae, *Xyrichthys novacula*, sex reversal.

Protogynous hermaphroditism is well documented in many species of fish of the Labridae family (Atz, 1964 ; Robertson and Choat, 1974 ; Reinboth, 1970, 1975). However, it is not still possible to generalize this phenomenon because its characteristics differ from species to species.

Little is known concerning the expression of sexuality in the genus *Xyrichthys*, which is present in the Mediterranean only with the species *novacula*. Two colour patterns have been described in this genus : an initial pattern of the female phase and a terminal pattern of the male phase (Oliver and Masutti, 1952 ; Randall, 1965).

Sordi (1967) confirmed the hypothesis postulated by Oliver and Masutti (1952) that *Xyrichthys novacula* is a protogynous hermaphrodite, and suggested that the sex change, as in most Labridae, is accompanied by colour change. Reinboth (1975), noted that the *novacula* species is monandric because the males always show a terminal colour pattern and they possess lobate testicular tissue protruding into the ovarian cavity in a manner comparable to the ovarian lamellae.

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Here we describe some aspects of sexual inversion in *Xyrichthys novacula* and report on the correlations between colour pattern and functional state of the gonads.

## Materials and Methods

The 48 specimens of *Xyrichthys novacula* studied were collected in the Bay of Naples. Within two hours of capture, the standard length (S.L.) of all specimens was measured to the nearest mm and the gonads were dissected and weighed to the nearest 0.1 mg. At the same time, the colour pattern (male or female) of each specimen was recorded. The dissected gonads were fixed in Smith's solution for not more than 6 hours. All gonads were dehydrated in alcohol, embedded in paraffin and sectioned in their entirety to a thickness of 6  $\mu$ m. Sections were stained with Mayer's haemalum and eosin.

## RESULTS

The characteristics of the colour pattern of *Xyrichthys novacula* are summarized in Table I. The histological analysis revealed some ovaries undergoing an early stage of transformation into testes. No preformed male tissue was found in the ovaries. Male tissue was found throughout the gonad. Initially there was a large scale breakdown of oocytes. Atresia seemed to include all the oocytes in the ovary, and a large number of follicle cells became phagocytic. Cystis of spermatogenic cells then developed, often adjacent to the epithelium of the lamellae, which suggests that cells originating within the epithelium become spermatogonia (Fig. 1 and 2).

All testes examined showed the presence of oocytes, atresic follicles (Fig. 3 and 4) and a central cavity in conjunction with an alternative path for the transport of sperm. (This suggests that the central cavity is non-functional and hence an ova-

Table I.— Characteristics of colour pattern in *Xyrichthys novacula*.

### Initial pattern (female)

- Body colour : pink; red on back
- faint, light blue vertical hachures, on the scales
- an irregular pearly white patch, constantly present in the posterior region and beneath the pectoral fin.

### Transitional pattern

- Body colour : pink, reddish, or greenish; dark red on back
- the hachures on the scales generally thicker than in the female
- the pearly white patch is absent.

### Terminal pattern (male)

- Body colour : green-blue, darker on the back, yellowish on the sides
- head : orange-yellow
- marked blue hachures on the scales
- a distinct yellow round spot on the base of the pectoral fin.



rian remnant). All these findings are evidence that the testes had developed from a preceding ovarian stage.

As can be seen from the distribution of the colour pattern in *Xyrichthys novacula* in relation to sex and length (see Table II), a change in pattern from the initial phase to the terminal phase accompanies the change from ovary to testis that occurs during sex-inversion. All fish with ovaries had the initial colour phase (S.L.  $\leq 140$  mm) and all fish, except three, with secondary testes had entered the terminal phase (S.L.  $\geq 120$  mm).

Table II.— Distribution of the colour phases in *Xyrichthys novacula* in relation to sexual phase and standard length (S.L.).

Colour phase	Sexual phase	n	Range S. L.
Initial	♀	32	8.8 - 14.2
Transitional	♀	2	12.6-13
Transitional	♂	3	11.7-14.8
Terminal	♂	11	12 -18.4

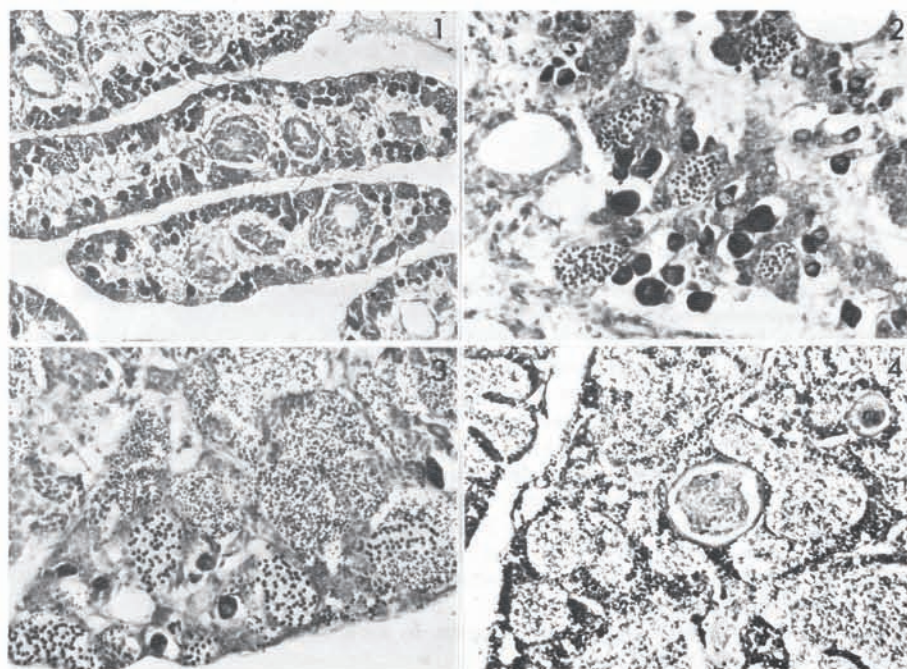


Fig. 1.— Early stage of sexual inversion in *Xyrichthys novacula*. (x 300)

Fig. 2.— Cysts of spermatogenetic cells adjacent to the epithelium of the lamellae. (x 750)

Fig. 3.— Mature testis with primary oocytes. (x 750)

Fig. 4.— Mature testis with a few remnant oocytes, stained yellow. (x 300)

## DISCUSSION

The histological analysis of the gonads of *Xyrichthys novacula* showed that all testes had primary oocytes and that the process of sex inversion starts from the cells adjacent to the epithelium of the lamellae. The latter observation suggests this species retains the ability to produce female germ cells.

The only other species in which studies have been conducted at the start of sexual inversion is *Coris julis*. In this species the origin of the testis can be traced back to particular groups of germ cells attached to the wall of the gonad during the female phase (Reinboth, 1970 ; Bentivegna and Rasotto, 1983). In *Xyrichthys novacula*, on the contrary, these cell groups are involved late in sex inversion, if at all.

The minimal length of the males, calculated from the correlations between colour pattern, size and functional state of the gonads, was shorter than that reported in other studies (Sordi, 1967 ; Reinboth, 1975). A single male-type only (monandry) is found also in the other species of this genus, e.g., *splendens* and *martinicensis* (Roede, 1975).

It would be interesting to study the social system in this species because, according to Warner and Robertson (1978), monandry tends to be found in small groups that are permanent in composition and location.

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